International Hydrographic Review, Monaco, LII (2), July 1975

AN AUTOMATED HYDROGRAPHIC SURVEY IN JAMES BAY, CANADA

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ABSTRACT

This paper describes the successful use of the Canadian automated system HAAPS (Hydrographic Acquisition And Processing System) in a 1973 survey of a shipping corridor.

PROLOGUE

Several individuals (DOUGLAS [1], BURKE [2], HUGGETT [3]) have discussed in detail the concept and development of automated survey systems within the Canadian Hydrographic Service. Until recently, the HAAPS (Hydrographic Acquisition And Processing System) has been considered as a development system only and given less credit by the field hydrographer than it perhaps deserves.

Following the recommendations of RITCHIE [4], in his paper given at the Canadian Institute of Surveying Conference in 1973, that hydrographers provide operational reports on new systems, the following report will outline the successful use of HAAPS on a production survey in 1973.

INTRODUCTION

The Canadian Hydrographic Service has been conducting field trials with the HAAPS system since 1969, when the Atlantic Region conducted trials on the St. Lawrence River. HAAPS is an automated Hydrographic Acquisition And Processing System which recently emerged from its development cocoon to production status. Although it is used by the

three Regional field offices in Canada, this paper mainly concerns itself with its use in Central Canada. Favourable results of field trials in Georgian Bay and on Lake Ontario in 1972 prompted the decision to use HAAPS on a production basis in 1973.

THE SURVEY AREA

In 1973 it was planned to use HAAPS in James Bay. The survey area was only a small portion of the 133 400 square miles of water in the Bay (see figure 1).

FIG. 1. — Sketch of general survey area.

In 1972, the Canadian Hydrographic Service began charting a safe shipping corridor from Hudson Bay to the mouth of La Grande Riviere using conventional survey methods. The bay is ice-free by the end of July, and except for the short shipping season, the east side of the Bay is accessible only by air. The 1973 survey would complete the corridor survey.

EQUIPMENT TRIALS

It was planned that three logging systems and one processing system would accompany the survey to James Bay. To prepare the hydrographers who would be using the system, the Development Section gave a two week "introduction to computer" course. An equipment trial, in the form of a

mini-survey on the west end of Lake Ontario, followed the course. This allowed the users to de-bug the equipment and devise new survey methods, while the "experts" were still close at hand for any necessary consultation.

It took nearly three weeks to overcome a number of equipment problems, many of which turned out to be faulty wiring or loose connections. At the end of the trials, enough data had been acquired to produce a sounding plot of the mini-survey area.

The equipment

The 1973 survey was based aboard the CCGS *Narwhal*, a 251 foot, ice-strengthened Depot Ship. Two 34 foot steel launches accompanied *Narwhal* to James Bay.

Mini-fix, an electronic positioning system, was used in conjunction with the HAAPS.

The HAAPS logging system comprised : (see figures 2 and 3)

Transceiver and Analog Depth Recorder.
Depth Digitizer.
Position Receiver (Mini-fix).
Digital Coupler.
Magnetic Tape Drive and Recorder.

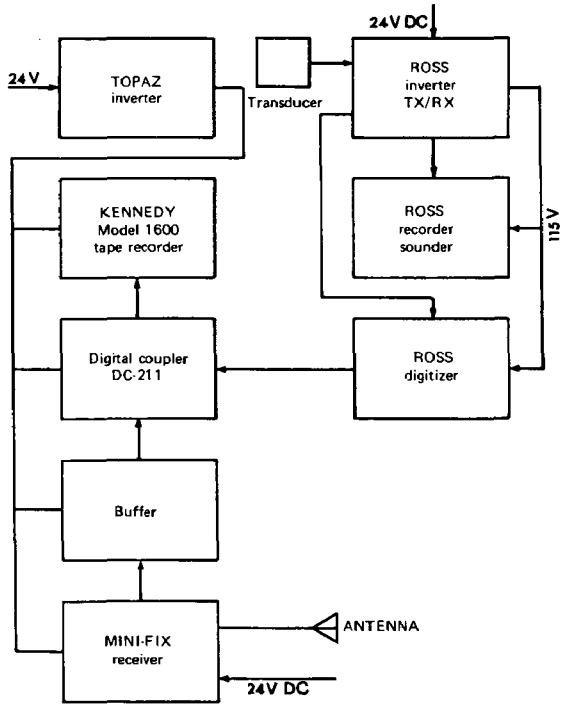

FIG. 2. — HAAPS logger – survey launches.

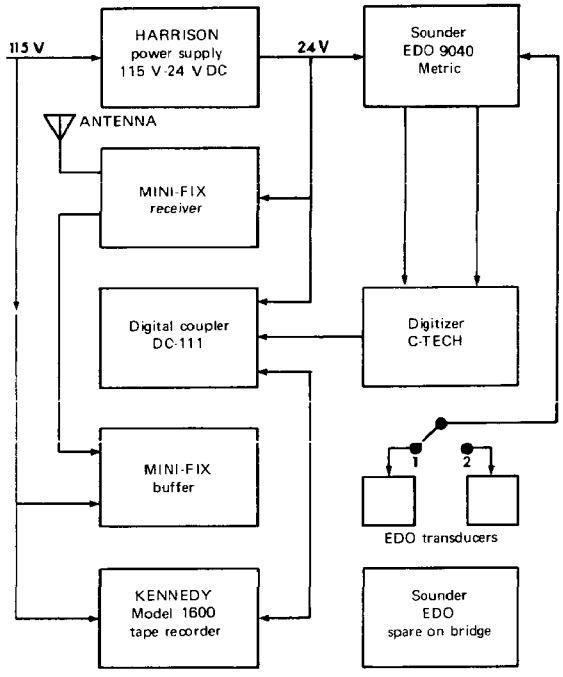

FIG. 3. — HAAPS logger – CCGS *Narwhal*.

The HAAPS processing system consisted of : (see figure 4)

Computer (PDP-8/E).
High Speed Paper Tape Reader and Punch.
Magnetic Tape Drive.
Drum Plotter.
Teletype and low speed paper tape punch.

Each survey launch contained a HAAPS logger. One HAAPS logger was installed in the radio office, just behind the wheelhouse, on the *Narwhal*; from there the sounder could be seen from the bridge. The HAAPS processor was installed below decks near the ship's centre of gravity. The installation did not include air-conditioning.

The Mini-fix positioning system was flown to James Bay in advance and activated and calibrated, using helicopters, to coincide with the arrival of the ship on James Bay on July 31st.

The survey

Narwhal began the survey with an oceanographic cruise in the north half of James Bay. All positions and soundings were logged by HAAPS and automatically plotted at a scale of 1/250 000.

The main sounding program began on August 4th. There were no major interruptions until early September when poor weather began to disrupt the work schedule. Down time during the month was limited to only a few hours. Mini-fix receivers and mechanical failures accounted for all down time; no delays were experienced due to HAAPS failures.

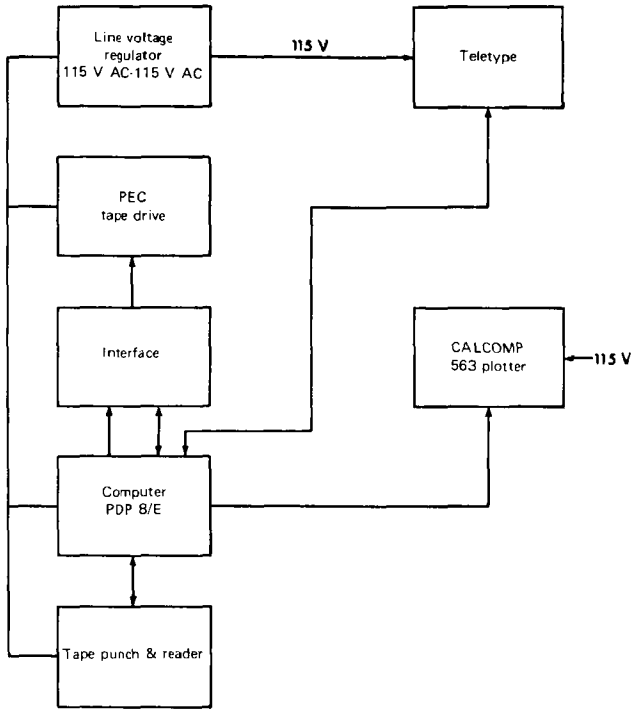

FIG. 4. HAAPS processor onboard CCGS *Narwhal*.

During good weather periods, the four hydrographers aboard the ship were employed as follows : one aboard each of the two survey launches, which sounded 12 hours each day; one recording data aboard the ship, which sounded 9 hours each day; and the fourth hydrographer employed on data processing and miscellaneous duties.

With the use of HAAPS, processing was kept up to date. Four sounding plots were completed, two at a scale of 1/50 000, and two at a scale of 1/25 000. Three of these plots covered areas where sounding was initiated in 1972 (see figure 5).

HAAPS

During equipment trials on Lake Ontario, survey methods were devised so that data could be retrieved using manual procedures. This meant keeping extensive notes in case of HAAPS failure.

The HAAPS system worked so well during the first part of the James Bay survey that manual logging procedures were soon abandoned and only a minimum of notes were kept. These notes consisted of :

Time equipment on/off.
Time plot on/off.
Administrative data (launch, date, sounder crystal frequency).
Bar check data.
Mini-fix reference buoy data.
Any unusual occurrence.

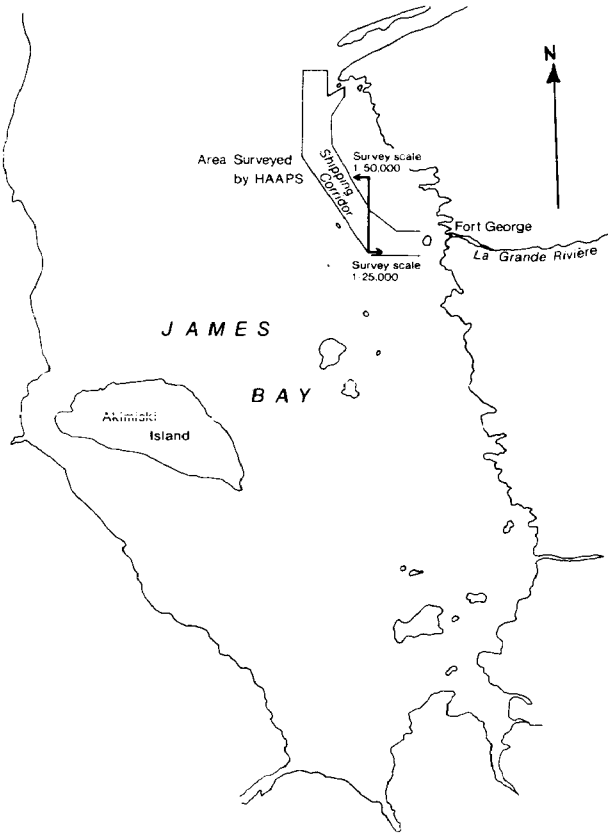

FIG. 5. — James Bay survey, 1973.

At the end of a work day, only a short de-briefing was necessary to point out any anomalies, and to organize the following day's program. The more usual methods of manual data processing (scaling a sounding roll and inking soundings on a sounding plot) would have required additional hydrographic personnel and much longer work hours.

The hydrographer employed in processing required 12 to 14 hours a day to analyse the data logged by three vessels (the ship and two launches). By the fourth week in August, after three weeks in the survey area, 6 792 sounding kilometres and 94 shoals had been processed in 213 computer hours.

The following programs were used to process HAAPS raw data tapes:

Program name	*Description*	*Percentage use*
a) Main Processor.	Selects deeps and shallows from raw data tape; Plots soundings. Output : punched paper tape; teletype listing; Calcomp sounding plot.	85%

b) Manual Data Recovery.	Recovers data missed by main processor; Replaces invalid data. Output : punched paper tape; teletype listing.	3%
c) Final Field Sheet Plot.	Plots final sounding plot (see figure 6); Edits output data from main processor. Output : punched paper tape (edited data); teletype listing; Calcomp plot-paper; flimsy (optional).	11%
d) Lane Jump Detector.	Detects Mini-fix lane jumps. Output : teletype listing.	1%

The program language used with the processing system was Focal.

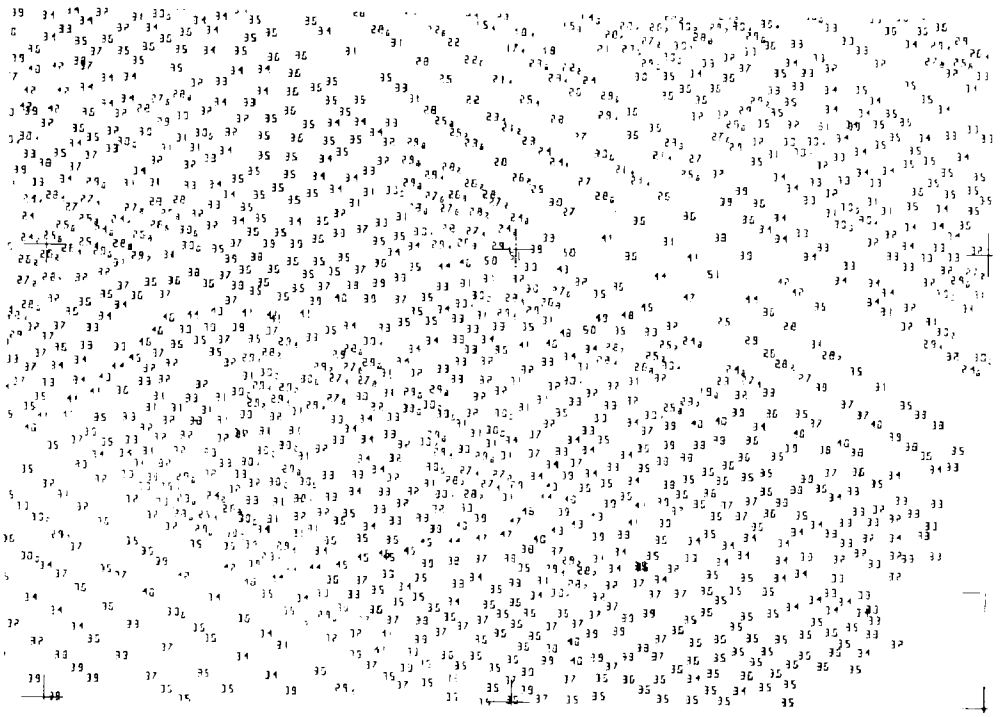

FIG. 6. — Calcomp plot-paper field sheet (soundings in metres).

The processing procedure was as follows :

1. Scan vessel notes for lane jumps and skip times.
2. Lane jump detector if required.

3. Main Processor — tide reductions, lane jump corrections are applied at this time.
4. Confirm sounding selection by visual inspection of sounding roll as soundings are being selected.
5. Manual data recovery if required.
6. Final Field Sheet Plot.

Collector sheets were plotted for each sounding plot, and these contained only edited data. The field party returned from the field with a paper collector sheet and a box of edited paper tapes containing position and depth as the final field product.

Because HAAPS was working so reliably, it was soon being utilized in areas other than regular sounding lines. A shoal examination technique was devised so that little or no overplot was evident. Bottom samples were logged on tape to process later. When Side Scan Sonar augmented the survey, HAAPS recorded positions and times and later plotted a track to use in conjunction with the sonar trace. Areas between the work area and base were easily sounded with HAAPS. Drogue positions, used in conjunction with a tidal current survey, were logged with HAAPS for plotting at a later date.

During a survey season of slightly less than two months, the following was completed :

349 shoal examinations;
1200 kilometres of sounding at 1/25 000;
5940 kilometres of sounding at 1/50 000;
1030 kilometres of sounding at 1/250 000.

All of this was logged by HAAPS in the field and processed by HAAPS using a total of 380 computer hours.

Completing the field sheet

The field party returned to the office by mid-October with a box of paper tapes and paper sounding plots. The plots prepared in the field were drawn on the flimsy paper normally used with drum plotters. They proved quite adequate as a means of developing the survey but are at present not acceptable for final field sheets.

During the first week back in the office, final data processing was completed. Then the paper tapes containing the edited bathymetry were copied onto magnetic tape using the PDP-8/E computer.

Soundings on this tape are sorted into ascending order of northings in overlapping bands of soundings. The width of the band depends on the scale of the survey. Overplots are deleted by comparing positions within the bands as well as comparing each band to the adjacent band.

Four plot tapes are produced :

1. Sounding plot (positions and depths with overplot removed).
2. Base plot (grids, graticules, stations and labels).
3. Title plot (field sheet title).
4. Bar scale plot (for sheets at a scale of 1/25 000 or larger).

A Gerber 22 Flatbed Plotter (50 by 60 inches plotting area and an accuracy of ±0.007 inches) is used for plotting the final field sheet. The plotter produces a pen and ink plot, on plastic, combining the information contained on the four plot tapes (see figure 7).

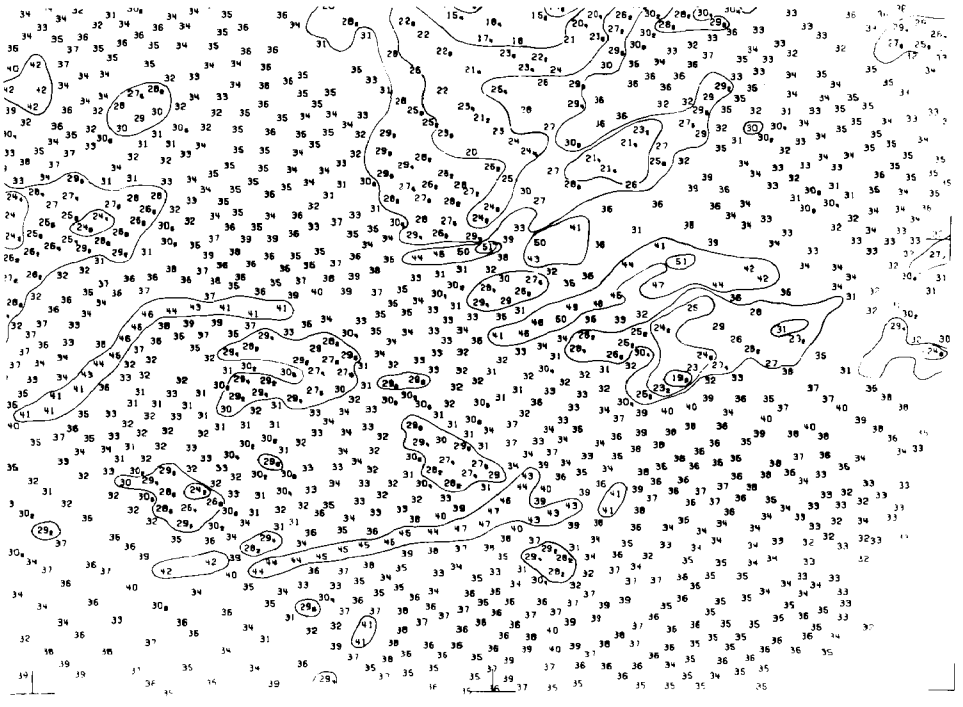

FIG. 7. — Gerber plot – finished field sheet (soundings in metres).

The hydrographer must manually add depth contours, bottom samples, shoreline, and navigational aids to complete the field sheet.

The final products are a field sheet in the traditional sense, and a magnetic tape which contains all the bathymetric data obtained during the field season.

Performance

During the course of the survey, the HAAPS logging systems worked for almost 1000 trouble-free hours. Their performance was more than satisfactory.

The HAAPS processing system worked relatively trouble-free for most of the summer. Near the end of the survey, the low-speed paper punch on the teletype began to falter after many hundreds of hours of operation. This made it necessary to process the final days' sounding after returning to the office. The pen assembly in the Calcomp Plotter required periodic cleaning or it would stick down.

The major problem was processing time, in particular the time involved in analyzing the logged data. A different computer language would help to speed things up, or computers could be placed aboard the launch to initially analyze data before it gets onto magnetic tape. This type of system could cost less if "off the shelf" items were used instead of specially made pieces of equipment.

Peripheral data such as tide reductions and lane jump corrections, are generally entered via the teletype. Some parameters may be entered via the high speed reader, but a data tape must still be created on the teletype.

Less time and paper tape would be expended in a "one pass" system. At present, each paper tape must be edited and a second paper tape produced before it is ready to be put onto magnetic tape.

On-line plotters have been discussed, but would probably not be feasible until present methods of obtaining tidal information and monitor corrections are updated.

CONCLUSION

The successful completion of the corridor survey from Hudson Bay to La Grande Riviere using HAAPS has proved without doubt that HAAPS is no longer a development system. It is now a production tool.

The present HAAPS system will receive continued use on our surveys. However a new and updated automated system is being implemented. This INDAPS (Integrated Navigation Data Acquisition and Processing System) processor replaces paper tape and reels by magnetic tape cartridges. A different computer language, Fortran instead of Focal, speeds up the processing. Each logger has its own mini-computer to analyze the data before it goes onto magnetic tape. With these improvements INDAPS should prove even more successful than the original HAAPS system.

ACKNOWLEDGMENT

The author would like to thank Mr. R.A. MARSHALL, the Hydrographer-in-Charge of the 1973 James Bay Survey, for permitting data and examples of his survey to be used in this report.

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